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(54) Apparatus and method for remotely determining the position, speed, and/or direction of movement of a movable object

(57) An electric or magnetic field of predetermined and measurable characteristics absent any altering effects is generated in a space which includes a movable member 12 to be monitored. The field is preferably generated by a drive circuit including a polyphase voltage source connected to a plurality of field forming electrodes 14 or coils arranged in symmetrical array, each of the field forming electrodes or coils receiving an input from said source of polyphase voltage in such a way that the impedance of any field forming member is discernible from the other members. A detecting circuit is connected to the drive circuit for detecting variations in the drive circuit inputs occurring as a result of the altering effect induced on the electric or magnetic field by the movable member e.g. by determining the vector sum of two voltages applied to each electrode. By taking a plurality of successive readings, the speed and direction of movement can also be determined.

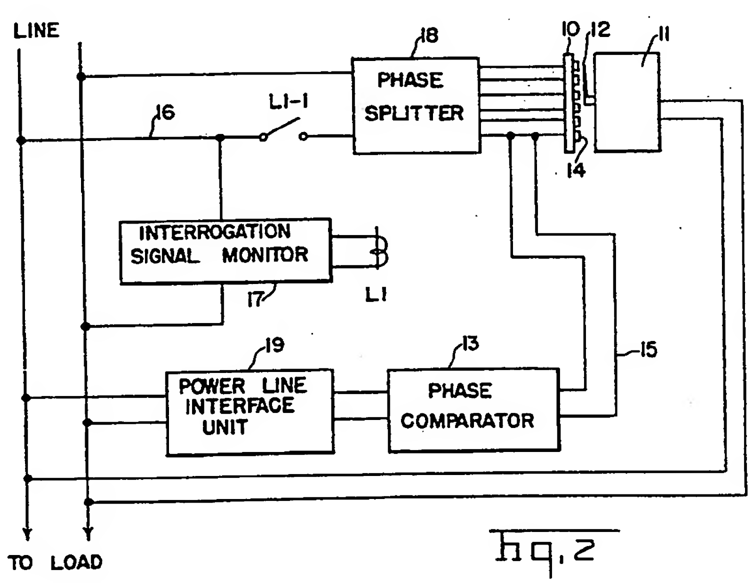

Fig. 2

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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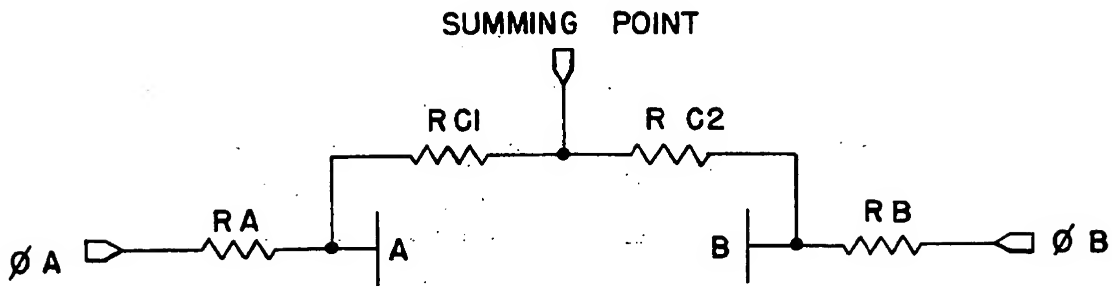
SUMMING POINT
R C1
R C2
R A
R B
Ø A
A
B
Ø B

Fig. 1

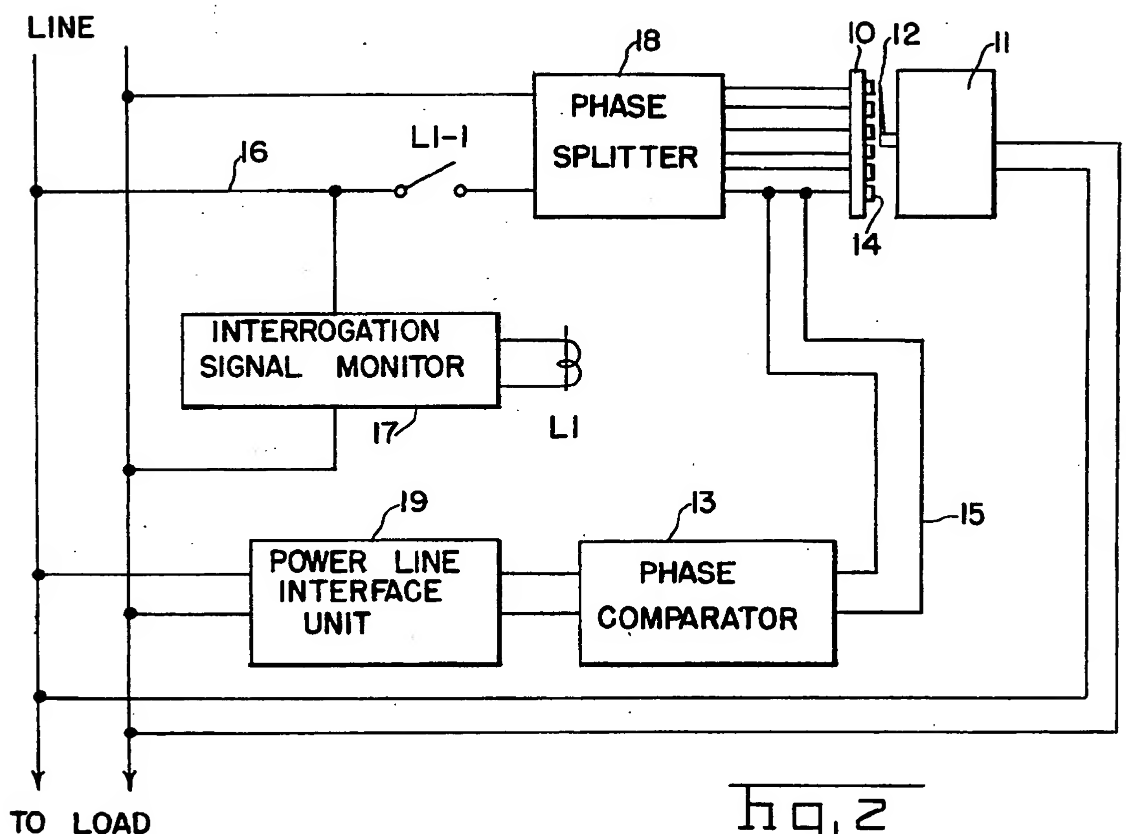
LINE
18
10
12
11
PHASE SPLITTER
16
L1-1
14
INTERROGATION SIGNAL MONITOR
17
L1
19
13
15
POWER LINE INTERFACE UNIT
PHASE COMPARATOR
TO LOAD

Fig. 2

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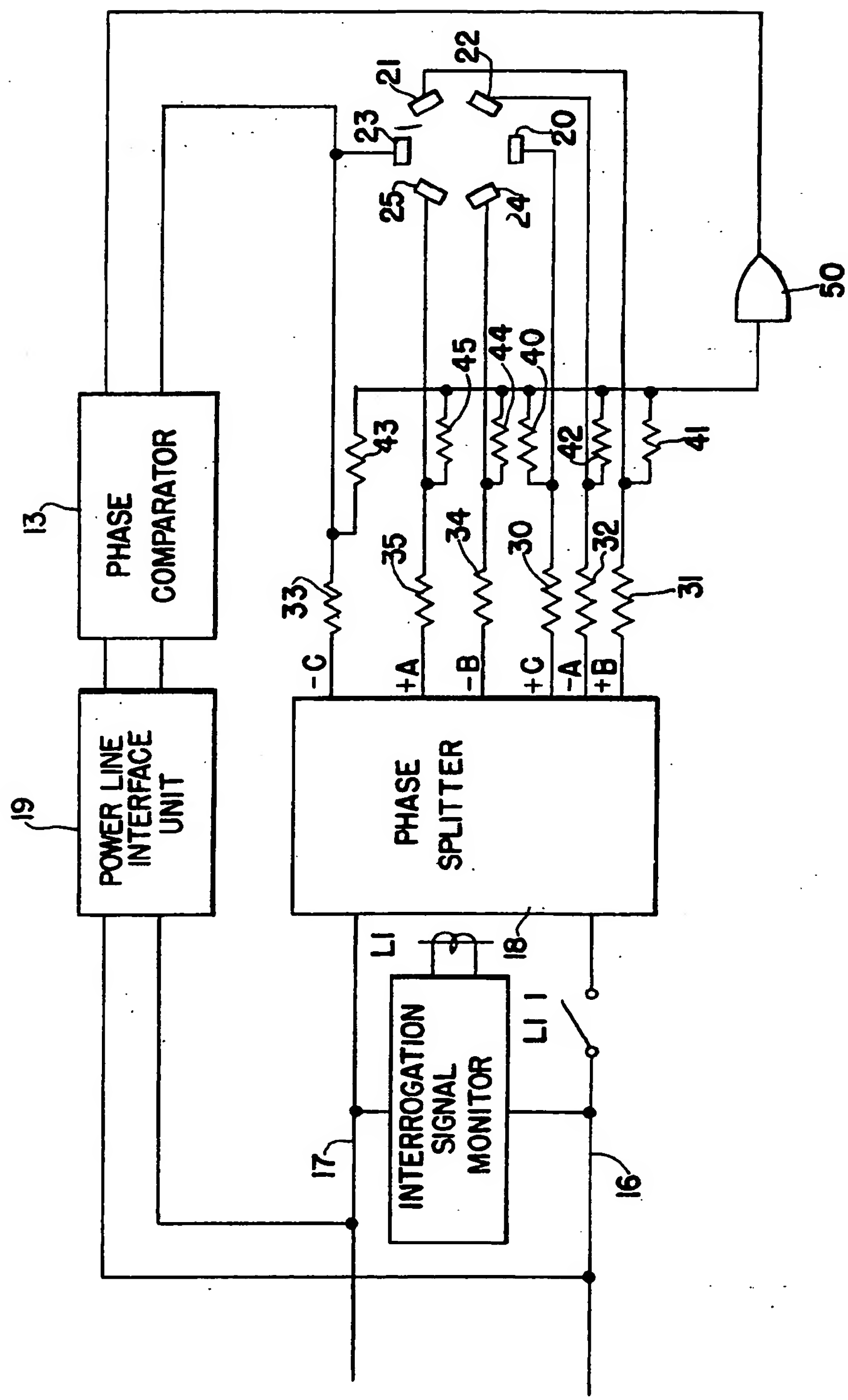

Fig. 3

SPECIFICATION

Apparatus and method for remotely determining the position, speed and/or direction of movement of a movable object

In commercial, industrial and domestic applications, it is often necessary to quickly determine the position of a movable body. For example, in all kinds of meters various remote means have been developed for determining the position, speed and/or direction of movement of such objects as shafts, dial or meter hands, and the like. It is also desirable to be able to adapt existing equipment with remote reading systems, which adapt the dials and meters of existing equipment to be easily read by new types of remote reading systems. For example, in electric utility systems, sufficient power-generating equipment must be provided at all times to supply power during relatively short periods of maximum consumption, however, much of this equipment otherwise remains idle for a major portion of each day. In order to encourage power consumption during minimum-demand periods by gradutated billing rates, or even to be able to disconnect non-essential portions of a customer's load when the customer exceeds a previously agreed consumption rate, rapid determination of an individual customer's consumption rate, commonly termed "demand" over a prescribed time interval, is necessary. Conventional processes and techniques in which a meter reading man travels from house to house and visually reads each meter is just not possible for such types of applications.

Heretofore, with the exception of previous work by and on behalf of one of the joint inventors, Charles J. Cain, such demand metering has been generally possible only through the use of specially equipped meters, which have been both expensive to manufacture and require replacement of existing meters. The above-described previous efforts on the part of Charles J. Cain have resulted in a remote meter reading system described in U. S. Patent Nos. 4,007,454 and 3,500,365 in which an electrical or magnetic transducer unit scans the dial of a meter by inducing a rotating electric ('454) or magnetic ('365) field which includes the meter hand without using any mechanical parts that move relative to one another, thereby reducing areas of possible trouble with the meter reading device. The fields generated in the above listed disclosures have an axis of rotation which coincides with the axis of rotation of the meter hand. A field sensing or reading device or electrode is positioned within the electric field, symmetrical with respect to the axis of rotation of the meter hand, for sensing a voltage change responsive to the crossing of the rotating member by the rotating electric field and emitting an output signal responsive to said voltage change. The theory of the aforementioned ('454) patent is that the rotating electric field can be capacitively coupled to the meter hand, as long as the meter hand is of a material whose dielectric constant is substantially distinct from that of the surrounding media, and then the hand is again capacitively coupled back to the reading electrode. Variations in the signal to the reading electrode give an indication of the field disturbance and thus the meter hand position.

While this system is quite satisfactory and applicable for installations in which the meter hand is insulated from the supporting shaft on which it is fixed, where the meter hand is grounded (as in situations in which there is no insulation between the hand and the shaft), the aforementioned technique can encounter difficulties. These difficulties arise in that a substantial portion of the signal may be shunted to ground, rather than returned back to the reading electrode.

Therefore, it has been desirable to develop a system which is specifically adapted for grounded type meter hands, which system overcomes the problems attendant to capacitive coupling of the signal from the drive electrodes to the meter hand, and then back to the reading electrode.

The present invention is directed to a system which includes a transducer unit that will provide for the remote monitoring of the position, speed and/or direction of movement of a movable or moving member, particularly in cases in which the movable member is formed of a material having an electrical conductivity or dielectric constant significantly different than that of the surrounding medium. While the system of the present invention was primarily designed for permitting remote monitoring of grounded hands, it is believed that it is also applicable to movable members which are not necessarily grounded, as long as they still meet the criteria of being formed of a material differing substantially in electrical conductivity or dielectric constant from that of the surrounding medium.

In general, the invention as contemplated in a preferred embodiment is effected by first generating an electric field of predetermined and measurable electrical characteristics absent any altering effects. The electric field is generated by a drive circuit wherein a source of polyphase voltage is connected to and provides a prescribed input to each of a plurality of field forming electrodes arranged in a symmetrical array. The input to each electrode is different in phase from the inputs to the other electrodes. The aforementioned electrodes are so positioned that the electric field formed when the drive circuit submits signals thereto includes the movable member to be monitored therein. A detecting sub-circuit or circuit means is electrically connected to each input line for detecting variations therein caused by the altering effect in the electric field introduced by the existence of the movable member in the field.

So arranged and adapted, the variations may be converted into intelligible information indicative of the position of the movable member which information can be transmitted to a prescribed

receiving location.

The apparatus described hereinabove, which may be referred to as an electrical transducer unit, has the ability to monitor or indicate the hand position of the meter dial at any particular time without requiring mechanical connection to the meter and without the provision of unreliable devices such as photoelectric cells. The only connection with the meter is through the electric field. In scanning the dial of any given meter as described herein, the electric field can be induced electronically without using any mechanical parts that move relative to one another, thereby reducing the possibility of maintenance problems with the meter reading device. Further, there are no spark producing switches involved with the device and method according to present invention, and therefore it may be used in explosive atmospheres.

Whereas the device described in the previous U. S. Patents Nos. 4,007,454 and 3,500,365 to Cain et al use a rotating electric or magnetic field with a reading electrode or coil symmetrically placed within the field with respect to the axis of rotation of the rotating member capacitively coupled to the meter hand by the rotating electric field, in the present invention the reading electrode is eliminated. While the electric field is capacitively coupled to the meter hand or other moving object, there is no return coupling necessary to any reading electrode, and the position of the moving member is determined by the resulting imbalance in the drive circuit forming the electric field.

In a preferred embodiment the electric field is formed by a polyphase voltage leading to a circular array of electrodes which, when energized, form a rotating electric field and a high impedance to the input to each electrode is utilized to make the reading more sensitive. A summing network, such as a resistive network, provides a net (algebraic) sum of all components at a summing point, where a measuring means obtains the vector sum of potentials from each branch to determine where and how great the imbalance or variation on the array. While a rotating electric field is described herein in connection with the preferred embodiment, other fields may also be utilized as long as (1) the behavior of the driving circuit elements forms a particular field which in the absence of any altering effect is known and measurable, and (2) the moving member causes an altering effect to the driving circuit through its disturbing action on the field. For example a series of fields, each superposed one on the other, or a raster might be used. The majority of this specification is directed to a description of the electric field approach. However, it should be recognized that the same concepts apply to a magnetic field approach, as long as the movable hand is magnetically responsive. Therefore the scope of the invention includes the magnetic, as well as the electric field approach, even though throughout most of the specification, the electric field only is described.

It is therefore an object of the present invention to provide an improved apparatus for remotely monitoring the position, speed, and/or direction of movement of a movable member, even if the member is grounded.

It is another object of the present invention to provide an apparatus and method of the type described which measures variations in the drive circuit input to an electric field, which variations are indicative of the position of the movable member in the field.

It is another object of the present invention to provide an improved method and apparatus for remotely monitoring the position of meter hands, and espectially grounded meter hands.

It is still another object of the present invention to provide a system for monitoring the position of a meter hand by obtaining the vector sum of polyphase voltage inputs to the electrodes forming an electric field from which vector sum the meter hand position can be determined.

Other objects and a fuller understanding of the invention will become apparent upon reading the following detailed description of a preferred embodiment along with the accompanying drawings in which:

Figure 1 is a schematic diagram of a simple circuit which illustrates the concept of the present invention;

Figure 2 is a schematic diagram showing a transducer according to the present invention in conjunction with a control circuit therefor; and

Figure 3 is a schematic wiring diagram showing the connection of the transducer with a detecting circuit.

In general terms, the present invention is directed to a system for detecting a disturbance in an electric field by sensing the imbalance or variation in the drive circuit to the field caused by the disturbance. Such a technique requires that the energy source producing the electric field be measurable and that variations in this measurement be proportional to the intensity and direction of the disturbance. Exemplary of the concept utilized in the present invention, refer now to Figure 1, in which a varying potential difference is applied between voltage sources labeled ØA and ØB and points A and B. Impedances RA and RB are equal in value as are drain resistors or impedances RC1 and RC2. The result of this arrangement is that the potential difference between the summing point and the element (such as an electrode) labeled A is equal to the potential difference between the summing point and the element (electrode) labeled B.

If an object, particularly a grounded object, with an electrical conductivity or dielectric constant significantly different from the dielectric constant of the space surrounding element A and B is placed in close proximity to either element A or element B it will cause a change in the potential difference of that element with respect to the other components of the system. Since the element(s) adjacent the aforementioned object is only part of an interdependent network consisting

of components RA, A, RC1, the summing point, RC2, RB and B, the change in charge on this element will produce corresponding changes in other elements such as in the line between impedance RA or RB and point A or B respectively. The summing point is, by definition of component values, the electrical center of the system. We can then use the potential difference between the summing point and the reference point for driving sources for ØA and ØB to determine the amount of disturbance caused by an object placed close to element A or element B and the direction of the disturbance will indicate at which of either element A or element B the disturbance occurred. Note that for such an arrangement to function, it is necessary that the electrical impedance of one or more elements such as A or B undergo a change in response to the position of the object. This requires that either the field be time dependent or that there be relative motion between the object detected and the field. Hence a stationary object can be monitored if the field is changing or a moving object can be monitored if the field is stationary.

Figures 2 and 3 are exemplary of the placement of three of such assemblies as shown in Figure 1 in a radial array to measure angular deviation of an object.

In general terms, the remainder of the present invention includes means for providing an electric field, and preferably a rotating electric field, utilizing a circular array of electrodes with an input thereto equal in value but different in phase. If the vector value of all the voltage inputs are summed vectorially normally there is no resultant discernible at the summing point, because the vector sum of all voltages at the center is zero. However, when placed in front of a meter dial or other moving or rotating member so that the field produced by the electrodes includes the movable member, a different result occurs. The meter hand, and particularly a meter hand that is grounded, whose electrical conductivity or dielectric constant differs from that surrounding medium, provides a pathway between the electrodes and ground, thereby draining a measurable amount of energy from the field and reducing the potential on the most adjacent electrode(s). The vector sum of the input voltage, which is then not zero, is proportional or indicative of the angular position of the meter hand. The resulting signal can then be monitored by any of several well known means and converted into intelligible information which can be transmitted to a prescribed receiving location.

Referring to Figure 2 of the drawings, the transducer generally designated at 10 is positioned adjacent the face of the meter 11 having a hand 12. The transducer 10 is so positioned that the axis of the electric field generated through the electrodes 14 thereof defines a path parallel to the circumferential path of the rotating meter hand and includes the meter hand therein. In accordance with the present invention, it is not necessary that the electric field be rotating, nor that the electric field be circular. It is only necessary that the electric field be known in size and shape, be symmetrical with respect to the movement of the meter hand, be measurable, and include the meter hand.

It should be understood that a wire or conductor 16 leads from a source of electrical voltage (generally single-phase), such as an electric power line or the like. A signal monitoring device 17 of conventional design is arranged so as to ignore the routine voltage changes occurring on wire 16 but to detect special voltage patterns (which may be superimposed thereon by the remote station and which constitute a request for a meter reading) and respond thereto by closing a switching device such as is represented by relay L1. With this arrangement the relay L1 or other switching device can be remotely energized to activate the transducer 10.

The wire 16 leads to a phase splitter 18. The phase splitter 18 converts the single phase voltage into a plurality of phases, for example, three phases to provide the rotating electric field. It will thus be seen that, when it is desired to read the meter 11 an interrogation signal is placed on the wire 16 which causes the signal monitor to energize the relay contact L1-1. When the contact L1-1 is closed, the single phase voltage through wire 16 will be split by the phase splitter 18 into a polyphase voltage, for example, as illustrated a three phase voltage in which the three phases are angularly spaced. As an inherent feature of properly connected polyphase voltage, an electric field will be generated that will rotate around the face of the transducer 10. The dial hand 12, which is formed of a material having a dielectric constant or electrical conductivity substantially different from the dielectric constant of the surrounding medium will cause an energy drain from the field resulting in turn in a voltage drain from the input to the adjacent electrodes 14. There will be a resulting imbalance of the inputs which can be detected as will be explained hereinafter. Generally, any material will work, such as metal, ceramic, or plastic; however, for the grounded hand a metal hand is preferred.

It can be seen that the wire or conductor 16 is connected through relay contact L1-1 to the phase splitter 18. The details of the phase splitter are not shown herein, this being a conventional apparatus, well known by those skilled in the art and it being understood, however, that phase splitter 18 can provide polyphase voltage, that is voltage of two phase, three phase, or any number of phases. Three phase voltage is perhaps preferably because three phase voltage is frequently available from conventional power lines so that phase splitter 18 might not be required. If three phase voltage is available from the power line, there will be three contacts such as contact L1-1, one of the contacts being in each of the three phase wires, and the phase splitter 18 will be replaced by three phase inverters so that the input to the transducer will consist of the three original phases and their inversions.

The six wires or conductors shown in Figure 3 exiting from phase splitter 18 are designated A, B, C, —A, —B, and —C, which will also designate the positive and negative polarities of the three phases: phase A, phase B, and phase C. It will be observed that wire +A is connected to electrode 25 with a high impedance or resistance member 35 interposed therein, and wire —A to electrode 22 with a high impedance or resistance means 32 interposed therebetween, these two electrodes being diametrically opposed on transducer 10. Similarly, wire B is connected to electrode 21 through resistance 31 and wire —B to the diametrically opposed electrode 24 through resistance 34, and likewise wire C is connected to electrode 20 through resistance 30 and wire —C to the diametrically opposed electrode 23 through resistance 33. The diametrically opposed pairs 20, 23; 21, 24; and 22, 25; are each wired with one electrode, e.g. 20, connected to the positive side of one phase (e.g. phase C), while the other electrode 23 is connected to the negative side of the same phase. Therefore a voltage applied to both electrodes will cause opposite polarity on each of the two electrodes of the electrode pair, so that an electric field will be provided between each electrode pair 20, 23; 21, 24; and 22, 25.

With this arrangement it will be understood by those skilled in the art that when phase C reaches its peak voltage there will be an electric field which is strongest between electrodes 20 and 23. A hundred and twenty (120) electrical phase degrees later, when phase B reaches its peak voltage there will be an electric field which is strongest between electrodes 21 and 24; and the same situation will be true for electrodes 22, 25 when phase A reaches its peak voltage. Thus a rotating electric field is provided.

A summing network, such as the plurality of drain resistors 40, 41, 42, 43 and 45 are placed in a detecting "sub-circuit" leading to a summing point 50. The aforementioned summing network, such as resistors 40-45 causes voltages to be sampled from each input line to each electrode 20—25 and delivered to the summing point. At the summing point 50 a conventional piece of equipment, such as phase comparator 13, for obtaining the vector sum of the potential differences coming from each input is provided. Normally, with no meter hand confronting the electrodes 20—25 the vector sum of the voltages at summing point 50 would be zero. However, because of the meter hand 12 the input to the electrodes 20—25 closest to the meter hand are going to drain voltage to ground, thereby creating an imbalance or variation in the input. The data gathered by the summing equipment at summing point 50 are passed to a phase comparator 13 through line 15, where its phase is compared with any reference phase such as —C. This phase difference is changed to intelligible information which is indicative of the position of the movable meter hand 12 and which can be transmitted to a prescribed receiving location through the power line interface unit 19.

The electrodes 20—25 may be printed onto a backing plate in the manner illustrated and described in United States Patent No. 4,007,454 with the exception that no centering or reading electrode is provided with outputs therefrom as these are not necessary with the present embodiment. Alternatively the drive electrodes might be shaped as illustrated and described in applicant's copending British Patent application No. 40640/77 filed September 30, 1977. Additionally the resistors 30—35 and 40—45, and the associated networks to a summing point 50 may be deposited on the same backing plate.

With the above-described arrangement it will be seen that normally the electric field will take a rather wide circuit from one of the electrodes (say electrode 20) to diametrically opposed electrode (electrode 23). When the dial hand 12 is positioned adjacent electrode 20, for example, the electric field will pass therethrough and as a result of the presence of the dielectrically different material of hand 12, a voltage or potential decrease will occur in the vicinity of electrode 20. This decrease in voltage will result in an imbalance or varying condition at the summing point described hereinabove, because the input to electrode 20 will undergo a voltage change and the vector sum will no longer be zero. At the summing point 50 the magnitude of voltage loss as well as its direction will be apparent, thereby making available intelligible information which can be passed to a receiving position. The information obtained from the equipment at the summing point 50 is measured by the conventional phase comparator circuit 13 and can be placed on the power line by conventional interface unit 19 to be received by billing equipment at the interrogating location.

In the magnetic field approach, the above drawings are still considered to be applicable if one assumes that the elements 14 are coils instead of electrodes, and if it is realized that hand 12 is magnetically responsive.

There is thus provided an improved apparatus for remotely determining the angular orientation, speed and/or direction of rotation of moving objects by means of the imbalance in the electric field forming drive circuit caused by the position of the moving object therein. It will, of course, be understood that the particular embodiments are here presented by way of illustration and are meant to be in no way restrictive. For example, as has been previously mentioned, the electric field provided is not necessarily a rotating electric field, not necessarily a circular electric field, the only requirement being that the electric field be of a given shape and the inputs thereto measurable. Also, while the description is mainly directed to the use of a grounded meter hand, a grounded meter hand is not absolutely necessary to the successful operation of the system, even though it is believed that the system works best in connection with the monitoring of grounded hands. Further, the movable member need not be a meter hand or a rotating member as it could be

any type of movable member (even linearly movable) formed of a material having a dielectric constant or electrical conductivity substantially different from that of the surrounding medium and which member is moving in an electric field of known shape. Other changes and modifications might be made, and the full use of equivalents resorted to, without departing from the scope or spirit of the invention.

CLAIMS

1. Apparatus for remotely monitoring the position, speed, and/or direction of movement of a movable member, which member is formed of a material having an electrical conductivity or dielectric constant significantly different than that of the surrounding medium, said apparatus comprising:

a) means for generating an electric field of given electrical characteristics absent any altering effects, said means including a drive circuit having a source of voltage connected to and providing a prescribed input to a plurality of field forming electrodes;

b) said electrodes so positioned that said electric field includes said movable member therein;

c) said drive circuit including a detecting circuit means therein for detecting variations in said drive circuit inputs caused by the altering effect in said electric field introduced by said movable member;

d) whereby said variations may be converted into intelligible information indicative of the position of said movable member which can be transmitted to a prescribed receiving location.

2. The apparatus according to Claim 1 wherein said source of voltage is a polyphase voltage source.

3. The apparatus according to Claim 2 wherein said detecting circuit means includes a relatively high resistance means between said source of polyphase voltage and each of said field forming electrodes and a branch from each input to a summing point, and a measuring means for obtaining the vector sum of the potentials from each branch to determine where and how great the imbalance is on said array.

4. The apparatus according to Claim 1 wherein said field forming electrodes are arranged in a symmetrical array.

5. The apparatus according to Claim 4 wherein said movable member is a meter hand, said electrodes are arranged in a circular array, and the plane of said array is parallel and adjacent to the plane formed by the rotation of said meter hand.

6. The apparatus according to Claim 1 wherein said movable member is a meter hand, and said means for generating an electric field comprises:

a) a plate positioned in spaced confronting, parallel relation to the path of rotation of said meter hand;

b) a plurality of electrodes defining a circular array around a centre point aligned with the axis of rotation of said meter hand;

c) successive electrodes being connected to successive phases of said polyphase voltage.

7. The apparatus according to Claim 6 wherein an even number of electrodes are utilized, and successive diametrically opposed pairs of said electrodes are connected to successive phases of said polyphase voltage source, one electrode of each pair connected to the positive side of the corresponding voltage phase and the other electrode connected to the negative side of the corresponding voltage phase.

8. System for determining the angular position, speed, and/or direction of rotation of a movable member as it rotates about an axis of rotation and defines a circumferential path comprising:

a) drive circuit including a source of polyphase voltage;

b) said drive circuit further including a transducer means for receiving said polyphase voltage and generating a rotating electric field which defines a path parallel to said circumferential path, the vector sum of all phases being zero in the absence of any altering effect;

c) a detecting circuit means for sensing a variation in the vector sums of the input voltage of said drive circuit caused by the position of said rotating member in said rotating electric field and emitting an output signal indicative of the position of said member;

d) said transducer means being positioned in confronting, spaced relation to said member, but in no way mechanically or electrically connected thereto other than that a portion of said rotating member is within the path of said rotating electric field;

e) comparator means receiving said output signal emitted from said detecting circuit means and translating the vector sum of the resulting input voltages into an electrical signal indicative of the position of said rotating member.

9. The apparatus according to Claim 8 wherein said transducer means comprises:

a) a plate positioned in spaced, confronting, parallel relation to said circumferential path;

b) a plurality of exciting electrodes arranged in a circular array symmetrically positioned with respect to said axis of rotation, successive ones of said electrodes being connected to successive phases of said polyphase voltage.

10. The apparatus according to Claim 8 wherein said transducer means comprises:

a) a plate positioned in spaced, confronting, parallel relation to said circumferential path;

b) an even-numbered plurality of exciting electrodes arranged in a circular array symmetrically positioned with respect to said axis of rotation, successive diametrically opposed pairs of said exciting electrodes being connected to successive phases of said polyphase voltage source, one electrode of each pair connected to the positive side of the corresponding voltage phase and the other electrode of said pair being connected to the negative side of the corresponding voltage phase.

11. A method for remotely monitoring the angular position, speed and/or direction of

movement of a movable member comprising:

a) generating an electric field or given characteristics absent any altering effects, which field includes said movable member therein as an altering effect;

b) detecting the variation in the input to said electric field caused by the presence of said movable member.

12. The method according to Claim 11 wherein the step of generating the electric field comprises:

a) arranging a plurality of electrodes in a given array with respect to the path of movement of said movable member.

13. The method according to Claim 12 wherein said given array is symmetrical.

14. The method according to Claim 13 wherein successive ones of said electrodes are connected to a polyphase voltage through separate input lines.

15. The method according to Claim 14 wherein said array is circular and the successive electrodes of said circular array are arranged in diametrically opposed pairs.

16. The method according to Claim 15 wherein said diametrically opposed pairs of said electrodes are connected to successive phases of said polyphase voltage source, one electrode of each pair being connected to the positive side of the corresponding voltage phase and the other electrode of said pair being connected to the negative side of the corresponding voltage phase.

17. The method according to Claim 14 in which the step of detecting variations in the input to said electric field comprises:

a) obtaining sample voltages from each of said input lines; and

b) detecting the vector sum of all of the sample voltages, which sum is caused to vary by the position of the rotating member.

18. Apparatus for remotely monitoring the position, speed, and/or direction of movement of a movable member, which member is formed of a magnetically responsive material, said apparatus comprising:

a) means for generating a magnetic field of given characteristics absent any altering effects, said means including a drive circuit having a source of voltage connected to and providing a prescribed input to a plurality of field forming coils;

b) said coils so positioned that said magnetic field includes said movable member therein;

c) said drive circuit including a detecting circuit means therein for detecting variations in said drive circuit inputs caused by the altering effect in said magnetic field introduced by said movable member;

19. The apparatus according to Claim 18 wherein said source of voltage is a polyphase voltage source.

20. The apparatus according to Claim 19 wherein said detecting circuit means includes a relatively high resistance means between said source of polyphase voltage and each of said field forming coils and a branch from each input to a summing point, measuring means for obtaining the vector sum of the potentials from each branch to determine where and how great the imbalance is on said array.

21. The apparatus according to Claim 18 wherein said field forming coils are arranged in a symmetrical array.

22. The apparatus according to Claim 21 wherein said movable member is a meter hand, said coils are arranged in a circular array, the plane of said array being parallel and adjacent to the plane formed by the rotation of said meter hand.

23. A method of determining the angular position, speed, and/or direction of movement of a movable magnetically responsive member comprising:

a) generating a magnetic field of given characteristics absent any altering effects, which field includes said member therein as an altering effect; and

b) detecting the variations in the input to said magnetic field caused by the presence of said movable member.

24. The method according to Claim 23 wherein the step of generating the magnetic field comprises:

a) arranging a plurality of coils in a given array with respect to the path of movement of said movable member.

25. The method according to Claim 24 wherein said given array is symmetrical.

26. The method according to Claim 25 wherein successive ones of said coils are connected to a polyphase voltage through separate input lines.

27. The method according to Claim 26 wherein said array is circular and the successive coils of said circular array are arranged in diametrically opposed pairs.

28. The method according to Claim 27 wherein said diametrically opposed pairs of said coils are connected to successive phases of said polyphase voltage source, one coil of each pair being connected to the positive side of the corresponding voltage phase and the other coil of said pair being connected to the negative side of the corresponding voltage phase.

29. The method according to Claim 24 in which the step of detecting variations in the input to said magnetic field comprises:

a) obtaining sample voltages from each of said input lines; and

b) detecting the vector sums of all of the sample voltages, which sum is caused to vary by

the position of the rotating member.

30. Apparatus substantially as hereinbefore described with reference to the accompanying drawings.

31. A method substantially as hereinbefore described with reference to the accompanying drawings.

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